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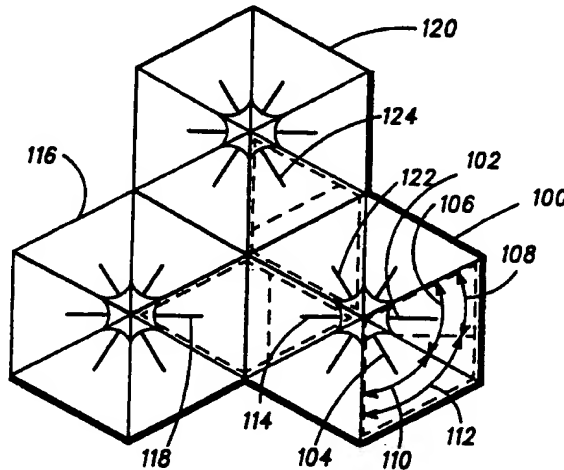
(57) Abstract

A method and apparatus is provided for dynamic distribution of a communication channel load of sectorized-antennae or omni-directional antennae of cell sites in a cellular radio communication system. The channel load is distributed by narrowing an antenna (102) beamwidth of an overloaded sector of a cell site (100) and widening an antenna (104) beamwidth of an adjacent sector of the cell site (100). In an alternative embodiment, the channel load is distributed by reducing power of an antenna (124) of a cell site (120) which is adjacent to an overloaded cell site (100). Alternatively, the channel load is distributed by increasing power of an antenna (118) of a cell site (116) which is adjacent to an overloaded cell site (100). Subsequent to the channel load distribution, each of the subscriber units in the overloaded (100) and adjacent cell sites (116, 120) are handed off to the particular cell site which is best able to service the subscriber units.

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METHOD AND APPARATUS FOR DYNAMIC DISTRIBUTION OF A COMMUNICATION CHANNEL LOAD IN A CELLULAR RADIO COMMUNICATION SYSTEM

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Field of the Invention

The present invention relates to communication systems which employ spread-spectrum signals and, more particularly, to a method and
10   apparatus for dynamically distributing communication channel load in a cellular radio communication system.

Background of the Invention

15   In general, the purpose of a communication system is to transmit information-bearing signals from a source, located at one point, to a user destination, located at another point some distance away. A communication system generally consists of three basic components: transmitter, channel, and receiver. The transmitter has the function of
20   processing the message signal into a form suitable for transmission over the channel. This processing of the message signal is referred to as modulation. The function of the channel is to provide a physical connection between the transmitter output and the receiver input. The function of the receiver is to process the received signal so as to

produce an estimate of the original message signal. This processing of the received signal is referred to as demodulation.

Two types of two-way communication channels exist, namely, point-to point channels and point-to-multipoint channels. Examples of point-to-point channels include wirelines (e.g., local telephone transmission), microwave links, and optical fibers. In contrast, point-to-multipoint channels provide a capability where many receiving stations may be reached simultaneously from a single transmitter (e.g. cellular radio telephone communication systems). These point-to-multipoint systems are also termed Multiple Address Systems (MAS).

In any communication system, there are two primary communication resources to be employed, namely, average transmitted power and channel bandwidth. The average transmitted power is the average power of the transmitted signal. The channel bandwidth defines the range of frequencies that the channel can handle for the transmission of signals with satisfactory fidelity. A general system design objective is to use these two resources as efficiently as possible. In most channels, one resource may be considered more important than the other. Hence, we may also classify communication channels as power-limited or band-limited. For example, the telephone circuit is a typical band-limited channel, whereas a deep-space communication link or a satellite channel is typically power-limited.

The transmitted power is important because, for a receiver of prescribed noise figure, it determines the allowable separation between the transmitter and receiver. In other words, for a receiver of prescribed noise figure and a prescribed distance between it and the transmitter, the available transmitted power determines the signal-to-noise ratio at the receiver input. This, subsequently, determines the noise performance of the receiver. Unless performance exceeds a certain design level, the transmission of message signals over the channel is not considered to be satisfactory.

Additionally, channel bandwidth is important because, for a prescribed band of frequencies characterizing a message signal, the channel bandwidth determines the number of such message signals that can be multiplexed over the channel. In other words, for a prescribed number of independent message signals that have to share

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a common channel, the channel bandwidth determines the band of frequencies that may be allotted to the transmission of each message signal without discernible distortion.

Analog and digital transmission methods are used to transmit a message signal over a communication channel. The use of digital methods offers several operational advantages over analog methods, including but not limited to: increased immunity to channel noise and interference, flexible operation of the system, common format for the transmission of different kinds of message signals, improved security of communication through the use of encryption, and increased capacity.

These advantages are attained at the cost of increased system complexity. However, through the use of very large-scale integration (VLSI) technology a cost-effective way of building the hardware has been developed.

One digital transmission method that may be used for the transmission of message signals over a communication channel is pulse-code modulation (PCM). In PCM, the message signal is sampled, quantized, and then encoded. The sampling operation permits representation of the message signal by a sequence of samples taken at uniformly spaced instants of time. Quantization trims the amplitude of each sample to the nearest value selected from a finite set of representation levels. The combination of sampling and quantization permits the use of a code (e.g., binary code) for the transmission of a message signal. Other forms of digital transmission use similar methods to transmit message signals over a communication channel.

When message signals are digitally transmitted over a band-limited channel, a form of interference known as intersymbol interference may result. The effect of intersymbol interference, if left uncontrolled, is to severely limit the rate at which digital data may be transmitted without error over the channel. The cure for controlling the effects of intersymbol interference may be controlled by carefully shaping the transmitted pulse representing a binary symbol 1 or 0.

Further, to transmit a message signal (either analog or digital) over a band-pass communication channel, the message signal must be manipulated into a form suitable for efficient transmission over the channel. Modification of the message signal is achieved by means of a

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process termed modulation. This process involves varying some parameter of a carrier wave in accordance with the message signal in such a way that the spectrum of the modulated wave matches the assigned channel bandwidth. Correspondingly, the receiver is required

5   to recreate the original message signal from a degraded version of the transmitted signal after propagation through the channel. The re-creation is accomplished by using a process known as demodulation, which is the inverse of the modulation process used in the transmitter.

In addition to providing efficient transmission, there are other

10   reasons for performing modulation. In particular, the use of modulation permits multiplexing, that is, the simultaneous transmission of signals from several message sources over a common channel. Also, modulation may be used to convert the message signal into a form less susceptible to noise and interference.

15   For multiplexed communication systems, the system typically consists of many remote units (i.e. subscriber units) which require active service over a communication channel for a short or discrete intervals of time rather than continuous service on a communication channel at all times. Therefore, communication systems have been designed to

20   incorporate the characteristic of communicating with many remote units for brief intervals of time on the same communication channel. These systems are termed multiple access communication systems.

One type of multiple access communication system is a frequency division multiple access (FDMA) system. In a FDMA system, the

25   communication channel is divided into several narrow frequency bands. Individuals communication channel links are established between two communication units within one of these narrow frequency bands. These communication links are maintained for discrete amounts of time while the two communication units transmit and receive signals. During

30   particular communication links between the two communication units, the communication system does not allow other communication units access to the narrow frequency band within the communication channel which is being utilized by the communication units in the particular communication link.

35   Another type of multiple access communication system is a time division multiple access (TDMA) system. In a TDMA system, the

communication channel is divided into time slices of a time frame to
allow communication links between two communication units to exist in
the same communication channel simultaneously, but at different time
slices. This is accomplished by assigning particular time slices of a time

5   frame to a particular communication link and other time slices to other
communication links. During these particular communication links
between the two communication units, the communication system does
not allow other communication units access to the time slice of the time
frame within the communication channel which is being utilized by the

10   communication units in the particular communication link.
            Further, another type of multiple access communication system is
a spread spectrum system. In a spread spectrum system, a modulation
technique is utilized in which a transmitted signal is spread over a wide
frequency band within the communication channel. The frequency band

15   is much wider than the minimum bandwidth required to transmit the
information being sent. A voice signal, for example, can be sent with
amplitude modulation (AM) in a bandwidth only twice that of the
information itself. Other forms of modulation, such as low deviation
frequency modulation (FM) or single sideband AM , also permit

20   information to be transmitted in a bandwidth comparable to the
bandwidth of the information itself. However, in a spread spectrum
system, the modulation of a signal to be transmitted often includes taking
a baseband signal (e.g., a voice channel) with a bandwidth of only a few
kilohertz, and distributing the signal to be transmitted over a frequency

25   band that may be many megahertz wide. This is accomplished by
modulating the signal to be transmitted with the information to be sent
and with a wideband encoding signal.
            Unlike FDMA and TDMA systems, in spread spectrum systems a
signal may be transmitted in a channel in which the noise power is

30   higher than the signal power. The modulation and demodulation of the
message signal using spread spread spectrum techniques provides a
signal-to-noise gain which enables the recovery of the message signal
from a noisy communication channel. The greater the signal-to-noise
ratio for a given system equates to: (1) the smaller the bandwidth

35   required to transmit a message signal with a low rate of error or (2) the

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lower the average transmitted power required to transmit a message signal with a low rate of error over a given bandwidth.

Three general types of spread spectrum communication techniques exist, including:

5   The modulation of a carrier by a digital code sequence whose bit rate is much higher than the information signal bandwidth. Such systems are referred to as "direct sequence" modulated systems.

          Carrier frequency shifting in discrete increments in a pattern
10   dictated by a code sequence. These systems are called "frequency hoppers." The transmitter jumps from frequency to frequency within some predetermined set; the order of frequency usage is determined by a code sequence. Similarly "time hopping" and "time-frequency hopping" have times of
15   transmission which are regulated by a code sequence.

          Pulse-FM or "chirp" modulation in which a carrier is swept over a wide band during a given pulse interval.

20   Information (i.e. the message signal) can be embedded in the spectrum signal by several methods. One method is to add the information to the spreading code before it is used for spreading modulation. This technique can be used in direct sequence and frequency hopping systems. It will be noted that the information being
25   sent must be in a digital form prior to adding it to the spreading code because the combination of the spreading code typically a binary code involves module-2 addition. Alternatively, the information or message signal may be used to modulate a carrier before spreading it.

          Thus, a spread spectrum system must have two properties: (1) the
30   transmitted bandwidth should be much greater than the bandwidth or rate of the information being sent and (2) some function other than the information being sent is employed to determine the resulting modulated channel bandwidth.

          The essence of the spread spectrum communication involves the
35   art of expanding the bandwidth of a signal, transmitting the expanded signal and recovering the desired signal by remapping the received

spread spectrum into the original information bandwidth. Furthermore, in the process of carrying out this series of bandwidth trades, the purpose of spread spectrum techniques is to allow the system to deliver error-free information in a noisy signal environment.

5   Spread spectrum communication systems can be multiple access systems like FDMA and TDMA communication systems. One type of multiple access spread spectrum system is a code division multiple access (CDMA) system. In a CDMA system, communication between two communication units is accomplished by spreading each transmitted

10   signal over the frequency band of the communication channel with a unique user spreading code. As a result, transmitted signals are in the same frequency band of the communication channel and are separated only by unique user spreading codes. Particular transmitted signals are retrieved from the communication channel by despreading a signal

15   representative of the sum of signals in the communication channel with a user spreading code related to the particular transmitted signal which is to be retrieved from the communication channel. A CDMA system may use direct sequence or frequency hopping spreading techniques.

     Each of these multiple access systems (i.e. FDMA, TDMA, and

20   CDMA) can be utilized in cellular radio communication systems. In cellular radio communication systems, factors which limit the performance of system are distortion and noise. Typically, in propagating through a communication channel, a transmitted signal is distorted because of nonlinearities and imperfections in the frequency

25   response of the communication channel. Other sources of degradation are noise and interference picked up by the signal during the course of transmission through the communication channel.

     There are various sources of noise in a CDMA spread spectrum communication system. The sources of noise may be internal as well as

30   external to the communication system. In CDMA the majority of noise in the communication channel is from signals which are being transmitted with unique user spreading codes. These spread signals contribute to the overall noise in the communication channel.

     To limit the noise in cellular communication systems as well as

35   increase the capacity of the cellular communication systems reuse the available, but limited number of communication resources. To ensure

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the re-use of communication resources does not cause unacceptable
noise in the communication channel, cell sites which are allocated the
same communication resources are geographically separated. By
having sufficient geographic separation, the noise in the communication
5   channel is limited. However, the geographic separation needed to
ensure an adequate signal to noise ratio (negligible noise in the
communication channel) limits the capacity of the communication
system because not all of the available communication resources may
be used in each cell site.

10   To enhance the efficiency of communication resource re-use and
to improve capacity of the cellular system, the cell sites can be divided
into sectors, wherein each sector contains a percentage of the available
communication resources. By having the cell sites divided into sectors,
the required geographic separation may be reduced while maintaining
15   an adequate signal to noise ratio. For example, U.S. Patent No.
4,128,740, assigned to Motorola, Inc. discloses a four cell - six sector
communication resource re-use pattern. As disclosed, each cell site is
divided into six sectors and each sector contains approximately 1/24 of
the available communication resources. For every four cell sites, the
20   communication resource pattern is repeated. This communication
resource re-use pattern may be further reduced to a one cell site re-use
pattern as disclosed in pending U.S. application 07/459,624 which was
filed January 2 1990 and also assigned to Motorola Inc.

          However, in a CDMA spread spectrum communication systems
25   most of the noise in the communication channel in a particular cell site is
from signals which are being transmitted with unique user spreading
codes within that particular cell site. Thus, a one cell site reuse pattern
is possible if the noise from cell sites surrounding the particular cell site
is ignored. The total number of communication links that a particular cell
30   site can simultaneously handle is related to the noise in the
communication channel which is from sources external to the system.
The use of this one site reuse pattern will limit the capacity of the
communication system in this particular cell site to handle
communication links, since noise from adjacent cell sites will be
35   considered a part of the external noise for the particular cell site.

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The present invention enhances the capability of spread-spectrum systems and, in particular, CDMA cellular radio-telephone systems to handle unequal channel loading of cells. In CDMA cellular radio-telephone systems, the "users" are in the same frequency band and separated only by unique user spreading codes. The number of users that can use the same frequency band is limited by the noise interference level. The noise interference level is directly related to the interference level created by the users actively using the frequency band and nearby cell sites operating in the same frequency band. The present invention dynamically changes the noise level present in a frequency band and the communication channel load of individual cell sites to increase the capacity of the communication system.

Summary of the Invention

A method and apparatus is provided for dynamic distribution of a communication channel load in a sectorized cellular radio communication system. The channel load is distributed by narrowing an antenna beamwidth of an overloaded sector of a cell site and widening an antenna beamwidth of an adjacent sector of the cell site and subsequently handing off subscriber units previously in the overloaded sector cell site to the adjacent sector cell site.

An alternative method and apparatus is provided for dynamic distribution of communication load in a radio communication system. The channel load is distributed by reducing power of an antenna of a cell site which is adjacent to an overloaded cell site, if the channel from an antenna of the overloaded cell site to an antenna of a subscriber unit is overloaded due to interference. Similarly, the channel load is distributed by increasing power of an antenna of a cell site which is adjacent to an overloaded cell site, if the communication channel from an antenna of a subscriber unit to an antenna of the overloaded cell site is overloaded due to interference. Subsequent to the occurrence of either channel interference condition, each of the subscriber units in the overloaded and adjacent cell sites are handed off to the particular cell site which is best able to service the subscriber units. This alternative

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method and apparatus can be applied to sectorized cell sites or cell sites having omni-directional antennae.

Brief Description of the Drawings

5
        FIG. 1 is a diagram showing a preferred embodiment set of sectorized cells of a radio communication system.

        FIG. 2 is a diagram showing an alternative preferred embodiment of cells of a radio communication system.

10
        FIG. 3 is a diagram showing an alternative preferred embodiment of cells of a radio communication system.

Detailed Description

15
        Typically in cellular radio communication systems, the coverage area of the communication systems is assumed to have equal distribution of channel load throughout the system. However, in reality, most subscriber units are not equally distributed throughout the cellular radio communication system and as such the channel load is not

20   equally distributed. For example, cars having subscriber units are on freeways during rush hours. Because freeways are locating in limited portions of the cell sites in a radio communication system, this location of subscriber units which desire service from a cell site during a particular period of time results in unequal cell site channel loading. Or more

25   particularly, one or more cell sites are more heavily loaded than surrounding cell sites.

        In the preferred embodiment, CDMA spread spectrum communication systems having one cell frequency reuse patterns are used. However, the present invention may be used by other types of

30   communication systems other than the preferred embodiment without departing from the teachings of the present invention disclosure. In a spread spectrum system, because the system is interference limited the capacity of a particular cell site is related in part to the amount of interference being contributed to the particular cell site from surrounding

35   cell sites and subscriber units in the particular cell site. It is desirable to dynamically distribute the communication channel load among the cell

sites such that some of the channel load from overloaded cell sites is assigned to the neighboring cell sites. This can be accomplished through the use of a number of different techniques.

      In one preferred embodiment, shown in FIG. 1 , a beamwidth

5   pattern 106 of an antenna 102 of an overloaded spread spectrum cell sector is narrowed to a reduced beamwidth pattern 108. In conjunction with this narrowing of an antenna beamwidth pattern, a beamwidth pattern 110 of an antenna 104 of an adjacent cell sector is widened to an increased beamwidth pattern 112. Subscriber units which were in

10   the beamwidth patterns of antennae 102 and 104 will be handed off automatically to the antenna best able to provide a communication channel to the individual subscriber unit. This handing off of subscriber units can be done by mechanisms already known in the art or any other suitable communication link handoff mechanism.

15   Handoff can be defined as the process of transferring a transmission in progress between one cell site and a subscriber unit to another cell site in coordination with both cell sites and the subscriber unit. Present radio communication systems require that the system continuously monitor the quality of every transmission in the

20   communication channel. The system recognizes when the quality of a transmission in the channel falls below a predetermined threshold in a particular cell site and determines if other cell sites can satisfactorily handle the transmission. Once a more suitable cell site is identified, the system sends instructions to the subscriber unit directing it to use

25   another communication channel for the current transmission. The subscriber unit confirms that it is leaving its current channel, switches to the new channel, synchronizes to the new channel and begins transmitting in the new channel.

      The effect of this narrowing and widening of antenna beamwidth

30   patterns is to transfer communication channel load from the overloaded cell sector to an adjacent cell sector which is able to handle an increased communication channel load.

      In an alternative embodiment, a sector of cell 100 is overloaded by interference in the communication channel link from an antenna 122

35   of the overloaded cell sector to an antenna of a subscriber unit. This interference in the communication channel link comes from cell sites

operating in the same frequency band as the overloaded sector cell as well as other sources. The overloaded sector cell initiates a request to an adjacent sector of an adjacent cell 120 to reduce its power at the antenna 124 servicing the adjacent cell sector. Alternatively, other

5   sectors of cell 100 can be considered adjacent sectors and as such may reduce their power as a result of a request by the overloaded sector cell. This reduction in the antenna 124 power effectively reduces the full capacity geographic boundaries of the sector serviced by the antenna 124 in conventional radio communication systems (e.g. two-way

10   trunking, ultra high frequency (UHF), very high frequency (VHF) radio communication systems). However, spread spectrum communication systems are not power limited, but rather are interference limited. Thus, the reduction of power at antenna 124 will not necessarily reduce the geographic boundaries or channel capacity of the cell sector serviced by

15   antenna 124. If this reduced antenna power cell sector is not operating near full capacity, then the antenna 124 and associated receiver can still recover transmissions between antennae of subscriber units and the antenna 124 of the reduced power cell sector which are in the communication channel at a reduced power. However, this reduction in

20   power of antenna 124 will reduce the interference in the communication channel link between an antenna of a subscriber unit to antenna 122 of the overloaded sector of cell 100. Thus, the communication channel capacity of the overloaded sector of cell 100 is increased. Also, subscriber units which were transmitting through the communication

25   channel to antennae 122 and 124 will be handed off automatically to the antenna best able to provide a communication channel to the individual subscriber unit after this reduction in power at antenna 124. This handing off of subscriber units can be done by mechanisms already known in the art and briefly described above or any other suitable

30   communication link handoff mechanism.

        This same technique of power reduction can be utilized by cells which do not have sectorized regions serviced by sectorized antenna. FIG. 2 show a diagram of such an alternative preferred embodiment of cells of a radio communication system. In this alternative embodiment, a

35   cell 200 is overloaded by interference in the communication channel link from an antenna 202 of the overloaded cell 200 to an antenna of a

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subscriber unit. This interference in the communication channel link
comes from cell sites operating in the same frequency band as the
overloaded cell site as well as other sources. The overloaded cell 200
initiates a request to an adjacent cell 204 to reduce its power at the
5   antenna 206 servicing the adjacent cell 204. This reduction in the
antenna 206 power effectively reduces the full capacity geographic
boundaries of the cell 204 serviced by the antenna 206 in traditional
radio communication systems. However, as previously described,
spread spectrum communication systems are not power limited, but
10   rather are interference limited. Thus, the reduction of power at antenna
206 will not necessarily reduce the geographic boundaries or channel
capacity of the cell 204 serviced by antenna 206. If this reduced
antenna power cell 204 is not operating near full capacity, then the
antenna 206 and associated receiver can still recover transmissions
15   between antennae of subscriber units and the antenna 206 of the
reduced power cell 204 which are in the communication channel at a
reduced power . However, this reduction in power of antenna 204 will
reduce the interference in the communication channel link between an
antenna of a subscriber unit to antenna 202 of the overloaded cell 200.
20   Thus, the communication channel capacity of the overloaded cell 200 is
increased. Also, subscriber units which were transmitting through the
communication channel to antennae 202 and 206 will be handed off
automatically to the antenna best able to provide a communication
channel to the individual subscriber unit after this reduction in power at
25   antenna 206. This handing off of subscriber units can be done by
mechanisms already known in the art and briefly described above or
any other suitable communication link handoff mechanism.

        Similarly in an alternative embodiment, a sector of cell 100 is
overloaded by interference in the communication channel link from an
30   antenna of a subscriber unit to an antenna 114 of the overloaded cell
sector. This interference in the communication channel link comes from
subscriber units in the overloaded sector cell which are operating in the
same frequency band as the overloaded sector cell as well as other
sources. The overloaded sector cell initiates a request to an adjacent
35   sector of an adjacent cell 116 to increase its power at the antenna 118
servicing the adjacent cell sector. Alternatively, other sectors of cell 100

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can be considered adjacent sectors and as such may increase their power as a result of a request by the overloaded sector cell. The increase in power of antenna 118 in the adjacent sector will cause the subscriber units being serviced by the antenna 118 to determine that the

5   communication channel link has improved with the antenna 118 since the signals being received from the increased power antenna 118 have improved due to their increased power. As a result of this perceived improvement in the communication channel link, the subscriber units in the adjacent sector cell will reduce their respective transmit power to the

10   antenna 118. This reduction in transmit power of the subscriber units in the adjacent sector cell will reduce the interference at the antenna 114. In addition, this increase in the antenna 118 power effectively increases the full capacity geographic boundaries of the sector serviced by the antenna 118. The increase of power at antenna 118 actually will reduce

15   the geographic boundaries or channel capacity of the cell sector serviced by antenna 114. This increased power of antenna 118 will allow the cell sector serviced by this increased power antenna 118 to recover transmissions in the communication channel which were formerly serviced by antenna 114. Thereby effectively reducing the

20   service area for antenna 114 and relieving channel load capacity of the overloaded sector of cell 100. The subscriber units which were transmitting through the communication channel to antennae 114 and 118 will be handed off automatically to the antenna best able to provide a communication channel to the individual subscriber unit after this

25   increase in power at antenna 118. This handing off of subscriber units can be done by mechanisms already known in the art and briefly described above or any other suitable communication link handoff mechanism.

     This same technique of power reduction can be utilized by cells

30   which do not have sectorized regions serviced by sectorized antenna. FIG. 3 show a diagram of such an alternative preferred embodiment of cells of a radio communication system. In this alternative embodiment, a cell 300 is overloaded by interference in the communication channel link from an antenna of a subscriber unit to an antenna 302 of the

35   overloaded cell 300. This interference in the communication channel link comes from subscriber units in the overloaded cell site which are

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operating in the same frequency band as the overloaded cell site as well as other sources. The overloaded cell 300 initiates a request to an adjacent cell 304 to increase its power at the antenna 306 servicing the adjacent cell 304. The increase in power of antenna 306 in the adjacent

5 cell 304 will cause the subscriber units being serviced by the antenna 306 to determine that the communication channel link has improved with the antenna 306 since the signals being received from the increased power antenna 306 have improved due to their increased power. As a result of this perceived improvement in the communication channel link,

10 the subscriber units in the adjacent cell 304 will reduce their respective transmit power to the antenna 306. This reduction in transmit power of the subscriber units in the adjacent cell 304 will reduce the interference at the antenna 302. In addition, this increase in the antenna 306 effectively increases the geographic boundaries of the cell 304 serviced

15 by the antenna 306. The increase of power at antenna 306 actually will reduce the geographic boundaries or channel capacity of the cell 300 serviced by antenna 302. This increased power of antenna 306 will allow the cell 304 service by this increase power antenna 306 to recover transmissions in the communication channel which were formerly

20 serviced by antenna 302. Thereby effectively reducing the service area for antenna 302 and relieving channel load capacity of the overloaded cell 300. The subscriber units which were transmitting through the communication channel to antennae 302 and 306 will be handed off automatically to the antenna best able to provide a communication

25 channel to the individual subscriber unit after this increase in power at antenna 306. This handing off of subscriber units can be done by mechanisms already known in the art and briefly described above or any other suitable communication link handoff mechanism.

  Although the invention has been described and illustrated with a

30 certain degree of particularity, it is understood that the present disclosure of embodiments has been made by way of example only and that numerous changes in the arrangement and combination of parts as well as steps may be resorted to by those skilled in the art without departing from the spirit and scope of the invention as claimed.

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Claims

What is claimed is:

5   1.   A method of dynamic distribution of communication channel load in a sectorized cellular radio communication system, comprising:

(a)   narrowing an antenna beamwidth of an overloaded sector of a cell of the radio communication system;

(b)   widening an antenna beamwidth of an adjacent sector of

10   the cell of the radio communication system; and

(c)   automatically handing off subscriber units which were previously in the antenna beamwidth of the overloaded sector cell to the adjacent sector cell.

15   2.   A method of dynamic distribution of communication channel load in a radio communication system, comprising:

(a)   reducing power of an antenna of a cell site of the radio communication system which is adjacent to an overloaded cell site of the radio communication system, if the

20   overloaded cell site is overloaded due to interference in a communication channel of the radio communication system from an antenna of the overloaded cell site to an antenna of a subscriber unit; and

(b)   automatically handing off subscriber units in the

25   overloaded and adjacent cell sites.

3.   The method of claim 2 wherein reducing the antenna power of the adjacent cell site comprises a technique selected from the group consisting essentially of:

30   (a)   reducing the antenna power of a sector of the overloaded cell site which is adjacent to an overloaded sector of the overloaded cell site.

(b)   reducing the antenna power of a sector of an adjacent cell site which is adjacent to the overloaded cell site.

4.   A method of dynamic distribution of communication channel load
      in a radio communication system, comprising:
      (a)   increasing power of an antenna of a cell site of the radio
             communication system which is adjacent to an overloaded
5   cell site of the radio communication system, if the
             overloaded cell site is overloaded due to interference in a
             communication channel of the radio communication
             system from an antenna of a subscriber unit to an antenna
             of the overloaded cell site; and
10   (b)   automatically handing off subscriber units in the
             overloaded and adjacent cell sites.

5.   The method of claim 4 wherein increasing the antenna power of
      the adjacent cell site comprises a technique selected from the
15   group consisting essentially of:
      (a)   increasing the antenna power of a sector of the overloaded
             cell site which is adjacent to an overloaded sector of the
             overloaded cell site.
      (b)   increasing the antenna power of a sector of an adjacent
20   cell site which is adjacent to the overloaded cell site.

6.   A sectorized cellular radio communication system having
      dynamic distribution of communication channel load, comprising:
      (a)   beamwidth control means for:
25   (i)   narrowing an antenna beamwidth of an overloaded
                    sector of a cell of the radio communication system;
                    and
             (ii)   widening an antenna beamwidth of an adjacent
                    sector of the cell of the radio communication system;
30   and
      (b)   handoff means for automatically handing off subscriber
             units which were previously in the antenna beamwidth of
             the overloaded sector cell to the adjacent sector cell.

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7.   A radio communication system having dynamic distribution of
      communication channel load, comprising:
      (a)   power control means for reducing power of an antenna of a
             cell site of the radio communication system which is
5   adjacent to an overloaded cell site of the radio
             communication system when the overloaded cell site is
             overloaded due to interference in a communication
             channel of the radio communication system from an
             antenna of the overloaded cell site to an antenna of a
10   subscriber unit; and
      (b)   handoff means for automatically handing off subscriber
             units in the overloaded and adjacent cell sites.

8.   The radio communication system of claim 7 wherein the power
15   control means comprises means selected from the group
      consisting essentially of:
      (a)   means for reducing the antenna power of a sector of the
             overloaded cell site which is adjacent to an overloaded
             sector of the overloaded cell site.
20   (b)   means for reducing the antenna power of a sector of an
             adjacent cell site which is adjacent to the overloaded cell
             site.

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9. A radio communication system having dynamic distribution of
    communication channel load, comprising:

    (a) power control means for increasing power of an antenna of
         a cell site of the radio communication system which is
5   adjacent to an overloaded cell site of the radio
         communication system when the overloaded cell site is
         overloaded due to interference in a communication
         channel of the radio communication system from an
         antenna of a subscriber unit to an antenna of the
10   overloaded cell site; and

    (b) handoff means for automatically handing off subscriber
         units in the overloaded and adjacent cell sites.

10. The radio communication system of claim 9 wherein the power
15 control means comprises means selected from the group
    consisting essentially of:

    (a) means for increasing the antenna power of a sector of the
         overloaded cell site which is adjacent to an overloaded
         sector of the overloaded cell site.

20 (b) means for increasing the antenna power of a sector of an
         adjacent cell site which is adjacent to the overloaded cell
         site.

1 / 1
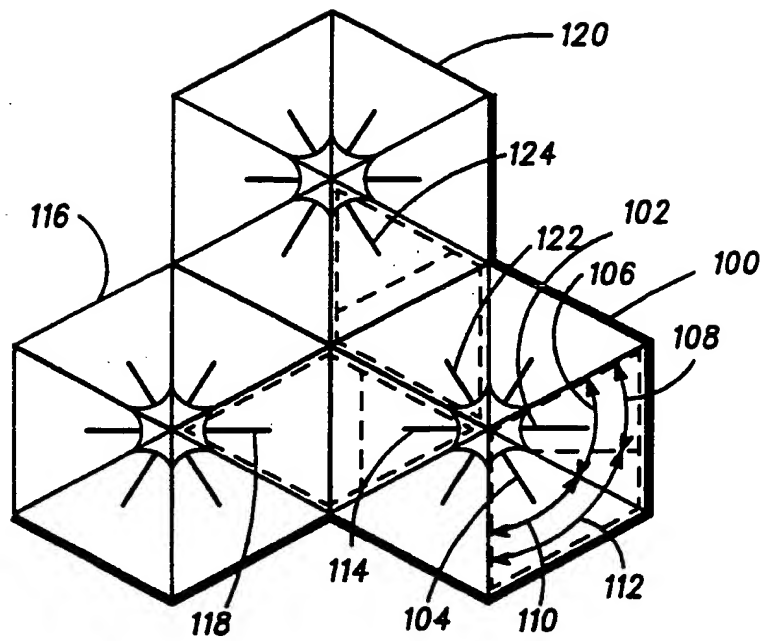
FIG.1
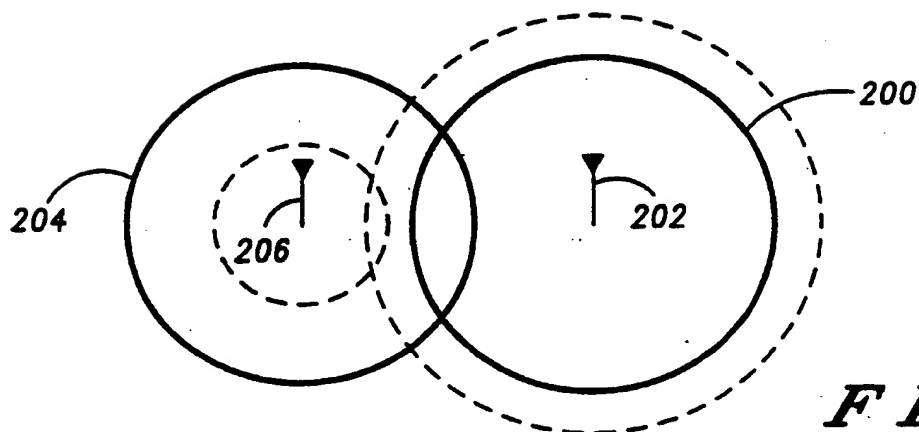
FIG.2
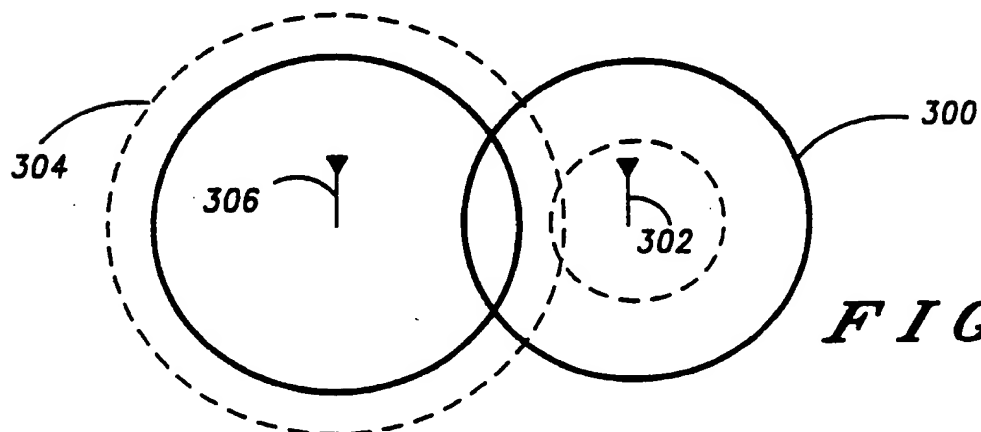
FIG.3

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/09673

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

INT CL(5): H04Q 7/00
U.S. CL: 455/33 379/59

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
U. S.	455/33,54,56,67 379/58,59,63

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched 8

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
Y, P	US, A, 5,040,238 (COMROE ET. AL.) 13 AUGUST 1991 See Entire document.	1-10
Y, P	US, A, 5,073,971 (SCHAEFFER) 17 DECEMBER 1991 See entire document.	1-10
A, P	US, A, 5,038,399 (BRUCKETT) 06 AUGUST 1991	1-10
A	US, A, 4,947,452 (HATTORI ET. AL.) 07 AUGUST 1990	1-10
A	US, A, 4,747,160, (BOSSARD) 24 MAY 1988	1-10

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25 FEBRUARY 1992	31 MAR 1992
International Searching Authority	Signature of Authorized Officer
ISA/US	CURTIS KUNTZ

Form PCT/ISA/210 (second sheet) (Rev.11-87)